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Phosphorus and Potassium Placement for No-Till Corn

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Introduction

The information presented is part of ongoing research to identify effective fertilizer placement methods and diagnostic tools for phosphorus (P) and potassium (K) in no-till and ridge-till corn and soybean. Results for no-till cornfields will be emphasized here. There is uncertainty about soil test interpretations and cost-effective methods of fertilizer application for the no-till system. Moreover, producers are uncertain about the value of soil testing in conservation tillage because of large variability and lack of knowledge concerning techniques for collection of samples. Broadcast placements are less costly than banded placements but they seem inefficient for no-till fields because fertilizers are not incorporated. Because of the reduced movement of P and K in soils, broadcast applications result in stratification of these nutrients and accumulations within the top 2 or 3 inches of the soils. Although residue cover usually improves root growth and root absorption efficiency at shallow soil layers, the stratification could result in lower P or K uptake by plants during dry periods.

Methods

Ten long-term trials (five P trials and five K trials) with corn-soybean rotations were established on five Iowa State University (ISU) research farms in 1994. Seven additional short-term trials (P and K combinations) were established during 1994 and 1995 on farmers' fields having histories of no-till management. Treatments are placements and rates of P and K fertilizers (dry granulated fertilizers). Rates used are 0 to 112 lb P_2O_5/acre and 0 to 140 lb K_2O/acre. For trials at research farms, placements are broadcast or deep-banded in the fall and planter-banded in spring, and the fertilizers are applied every year to corn and soybean in the rotation (both crops were grown each year in adjacent portions of the fields). For trials on farmers' fields, dry fertilizers were applied broadcast or deep-banded, and in some trials an additional liquid N-P-K starter treatment was included. The coulters and knives of the deep bander were setup to apply fertilizer at a 6 to 8 inch depth and at the row width used by each producer (30 to 38 inches). The planter-applied fertilizer was banded 2 inches beside and 2 inches below the seeds. An additional treatment consisting on an "empty coulter-knife" deep-band pass was included in all trials. Corn was planted in 30-inches rows and, in deep-banded plots, the rows were on top of the knife tracks.

Results

Phosphorus. Phosphorus fertilization increased yields at five soils that tested very low or low in soil-test P and at one site testing optimum. Maximum yields were always achieved with the lowest rates used (28 lb P_2O_5/acre). Because of the lack of significant differences between P rates, average responses to P placement are shown in Table 1 for trials at ISU research farms and in Table 2 for on-farm trials. The placement treatments did not differ at any of the seven trials conducted in 1994. Corn yields were higher (statistically significant differences) for the deep-banded placement compared with the other placements in two of 10 trials conducted in 1995. The broadcast and planter-banded placements did not differ in the responsive site that included all three placements (Site 7, Table 2). Deep-banded and planter-applied P increased early plant growth compared with the broadcast placement in many fields (not shown).

Table 1. Effect of P fertilizer placement on yields of no-till corn for trials on ISU research farms.

			Phosphorus treatment				Statistics‡	
Site	Year	Soil P†	Control	Broadcast	Deep-band	Planter-band	Placement	Fertilizer
			---------- bu/acre ----------					
1	1994	O	167	172	167	166	ns	ns
2	1994	H	152	151	154	158	ns	ns
3	1994	L	153	161	162	159	ns	s
4	1994	VH	131	135	135	144	ns	ns
5	1994	VL	132	141	136	144	ns	s
6	1995	O	170	163	167	163	ns	ns
7	1995	O	131	129	137	125	s	s
8	1995	L	140	145	151	146	ns	s
9	1995	VH	105	107	115	107	ns	ns
10	1995	VL	99	113	111	110	ns	s
Means over all sites			138	142	143	142	ns	s

† Iowa State University soil-test interpretation classes Very Low, Low, Optimum, High, and Very High.
‡ ns and s = nonsignificant and significant treatment effects, respectively.

Table 2. Effect of P fertilizer placement on yields of no-till corn for on-farm trials.

			Phosphorus treatment			Statistics	
Site	Year	Soil P	Control	Broadcast	Deep-band	Placement	Fertilization
			---------- bu/acre ----------				
21	1994	H	202	206	203	ns	ns
22	1994	L	183	194	184	ns	ns
23	1995	VH	129	130	132	ns	ns
24	1995	L	115	122	122	ns	ns
25	1995	VL	120	127	130	s	s
26	1995	VL	176	183	184	ns	ns
27	1995	H	119	125	130	ns	ns
Means over all sites			149	155	155	ns	s

Potassium. Potassium fertilization increased yields at five sites, and responses were not clearly related to soil test values. Maximum yields were always achieved with the lowest rates used (35 lb K_2O/acre). Average responses to K placement are emphasized in this report and are shown in Tables 3 and 4. In 1994 fertilization did not increase yields at any site and the placement treatments did not differ at any trial. In

1995, the deep-banded placement produced higher yields than the other placements in three of the five responsive sites. The control and the broadcast and planter-banded placements did not differ in the responsive site that included all three placements (Site 16, Table 2). Early plant growth was not affected by the K placement method (not shown).

Table 3. Effect of K fertilizer placement on yields of no-till corn for trials on ISU research farms.

			Potassium treatment				Statistics	
Site	Year	Soil K	Control	Broadcast	Deep-band	Planter-band	Placement	Fertilizer
			---------- bu/acre ----------					
11	1994	VH	163	162	161	165	ns	ns
12	1994	O	165	168	169	163	ns	ns
13	1994	O	162	163	170	171	ns	ns
14	1994	H	134	135	139	131	ns	ns
15	1994	H	162	157	164	161	ns	ns
16	1995	VH	150	156	164	150	s	s
17	1995	H	131	132	137	132	ns	ns
18	1995	O	150	152	159	157	ns	s
19	1995	H	110	108	112	110	ns	ns
20	1995	VH	109	113	113	111	ns	s
Means over all sites			144	145	149	145	s	s

Table 4. Effect of K fertilizer placement on yields of no-till corn for on-farm trials.

			Potassium treatment			Statistics	
Site	Year	Soil K	Control	Broadcast	Deep-band	Placement	Fertilizer
			---------- bu/acre ----------				
21	1994	O	194	210	200	ns	ns
22	1994	VH	194	194	200	ns	ns
23	1995	VH	130	135	141	s	s
24	1995	H	113	118	130	s	s
25	1995	VH	123	127	122	ns	ns
26	1995	O	169	176	179	ns	ns
27	1995	H	123	125	136	ns	ns
Means over all sites			149	155	158	s	s

Work is still in progress to relate yield responses to soil test values measured at various sampling depths and to study the economics of the responses. The yield responses to placements were small in many instances and would not offset additional application costs. The more frequent responses to placement in 1995 could be explained by conditions of limited moisture in June and early July of this year. In this situation, dry surface soil probably limited nutrient uptake when the fertilizers were applied on the surface or in shallow bands.

P-K starter fertilization. The response of no-till corn to liquid P-K mixtures applied with the planter was tested at six farmers' fields. The mixture was either 7-21-7 or 6-18-6, and high rates of N were applied by hand on the day of planting and after planting to minimize any response to the N in the mixture. The two fields used in 1994 had received broadcast P and K fertilization. In 1995, the response to the starter was tested at four sites in plots with or without broadcast P-K fertilization the previous fall. Data in Table 5 shows that the starter without P-K preplant increased yields at most sites (the response was statistically significant at one site and meaningful, although nonsignificant, at three sites). When preplant P-K was applied at recommended rates, however, the response to the starter was eliminated. It is noteworthy that the starter increased early plant growth significantly in most fields (not shown). The yield results tend to agree with data from conventionally tilled soils, which show that responses to starter P-K are unlikely in high testing soils or when preplant P or K is applied before planting in spring or fall.

Table 5. Response of no-till corn to liquid N-P-K starter with or without preplant fertilization.†

		Preplant (fall) P and K fertilization					
		None			Maintenance or as needed		
Year	SITE	No starter	Starter	Statistics	No starter	Starter	Statistics
		------ bu/acre -----			------ bu/acre -----		
1994	1	-	-	-	203	199	ns
1994	2	-	-	-	192	194	ns
1995	3	129	134	ns	132	129	ns
1995	4	115	116	ns	132	127	ns
1995	5	121	126	ns	129	131	ns
1995	6	173	199	s	191	192	ns
Means over all sites		134	144	s	163	162	ns

† High N rates were applied at planting to minimize N starter effects.

Conclusions

The results suggest that the placement of P fertilizer did not affect yields of no-till corn. Deep banding of K fertilizer increased yields of no-till corn compared with broadcast or planter-banded placements in some fields, although the yield increases would not always offset the higher application costs. It is possible, however, that occasional deep-banding (every two or more years) could be a profitable practice especially for K. Results for starter fertilization showed that response of no-till corn to P and K in starter mixtures would be unlikely when it is used after applying normally recommended preplant P and K rates. These conclusions should be considered preliminary because yields will be collected from several additional trials in 1996 and 1997.